SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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OUR RAILWAY SYSTEM.

Nearly eight years have elapsed since Mr. Robert Stephenson, in his inaugural address to the Institute of Civil Engineers, summarised the railway progress of the United Kingdom, and dwelt, with all the power of a master mind, upon the principles by which railways should be regulated and should regulate themselves. Up to the end of 1854, as Mr. Stephenson told us, the aggregate length of the railways opened for traffic in Great Britain measured 8054 miles—about the diameter of the globe, and nearly 500 miles more than the united length of the chief rivers of Europe, the great highways of commerce before railroads were constructed. Between 1854 and 1863 we added 3500 miles to this communication—the total length of the lines opened for traffic on January 1 last having been 11,551 miles, of which 682 miles, or 1-6th per cent. of the whole, were opened only last year. Our railway system has, therefore, been increasing very rapidly since Mr. Stephenson wrote. Districts of the country have been traversed, and new localities penetrated, opening up important channels of communication, intercourse, and trade. In 1845 the railway system was thought to have been tolerably well developed as regarded the main channels of communication, yet the number of passengers has increased in the following remarkable manner:—

Year.	Passengers.	Year.	Passengers.
1845	33,791,000	1859	149,757,000
1850	72,854,000	1860	163,436,000
1854	111,206,000	1861	173,721,000
		1862	180,429,000

Mr. Stephenson observed that the number of passengers had "more than trebled itself in ten years;" had he happily survived until to-day he would have been able to remark a proportionate increase extending over double that period. The traffic of railways is, indeed, of continuous growth. It is affected only by the general prosperity of the country. The returns from it do not grow in proportion to the extension of trade, because competition necessitates some reduction of rates, and the natural tendency of a largely increased business is to induce concessions for the purpose of securing it. But the amount received by our railway companies for conducting the traffic of the country is a large and annually increasing amount. The total receipts of the railway companies from all sources have been—

1845	£ 6,209,000	1860	£27,766,000
1850	13,204,000	1861	28,565,000
1854	20,215,000	1862	29,128,000
1859	25,743,000		

These are marvellous results. Under the old coach system it was assumed that ten passengers was the average number carried by a coach. To have provided for the transit of such a number of passengers as are now carried, at the ordinary rate of stage-coach traffic, no less than *eighteen thousand* coaches would have been required daily on our roads. The saving to the nation by railway facilities may be estimated by simply considering what would have been the cost of working 18,000 coaches daily throughout the year, against the amount at present received for passenger traffic by the railway companies. With respect to goods and minerals, it is obvious that without railway facilities 30,000,000 tons of merchandise and 63,000,000 tons of minerals could not have been carried at all.

The capital of the public embarked in our railway companies appears now to exceed the enormous item of 450,000,000*l.* It is difficult to realise such a sum to the imagination. No one ever possessed such an amount—no nation ever possessed it, or was ever able at once to raise it: 450,000,000*l.* is some seven or eight times the amount of the annual value of all the real property of Great Britain. It is more than one-half of that National Debt, the total of which we are always accustomed to fancy has reached the limit of the multiplication-table. But this four hundred and fifty millions of money—what does it represent?—the comfort, the happiness, the prosperity—even in many cases the existence—of how many thousand families?

Mineral Traffic.—The value and importance of the mineral traffic now carried on by our railways is remarkably illustrated by a single fact. The whole coal supply of the metropolis in 1860 was 5,000,000 tons, of which 3,500,000 tons were seaborne, and 1,500,000 tons were brought by railway. But it appears that the minerals carried by the railways of the United Kingdom in the same year exceeded 60,000,000 tons, or twelve times the amount of all the coals consumed in London. Of course, under the head of mineral traffic is included a vast number of items besides coal, such as ironstone, copper ore, &c.; but still the great bulk of this enormous traffic must have been coal traffic. The effect upon the nation of this still rapidly increasing trade cannot be estimated too highly.

In the course of the last Session of Parliament evidence was given before the committee on the Beckenham, Lewes, and Brighton line of railway showing that, within 30 miles of the metropolis (between East Grinstead and Lewes), there is even now a large rural population in which coal is still unused. "Their only fuel," said the clergy and magistrates of the district, "consists of roots of trees grubbed from the earth." In other important localities, up to within a very recent period, "a few scanty sticks gathered from a hedge" formed the only fuel of the labourers' winter fire. A district in Ireland, not very far from Dublin, which, unfortunately, was void of turf, was so absolutely destitute of fuel until a railway penetrated it that it was impossible to maintain a stick in the parish. This paucity of fuel has been an abundant source of crime. Man has been described as "a cooking animal;" and, however little he may have to cook, fire is absolutely necessary for the purpose. In such a climate as ours warmth is as needful during the winter months as shelter. Without warmth there can be no comfort; indeed, chemically considered, warmth is an addition to the supply of food. The absence of fuel to supply this warmth was naturally an incentive to crime. By bringing a supply of fuel within the reach of our remote populations, railways are, therefore, exercising a directly beneficial influence on our social system. They are acting as ameliorators of the human race, repressing crime by the best possible means—that of prevention.

Nor is it alone in the carriage of coals to localities requiring them that the railroads are operating beneficially for the nation. They are opening out a number of new fields which, without them, could never have been developed. The Northumberland and Durham coal fields, being situate upon a seabroad, were, before railroads existed, the only available sources of supply, except for local purposes. But since railways have enabled us to obtain supplies of coals by inland carriage, the sources of supply have increased nearly sevenfold. The Yorkshire, Derbyshire, and Nottinghamshire coal field, from which much larger supplies are now obtained, is estimated to cover an area of 760 square miles, and the coal field of Glamorganshire, from which coals are now supplied so largely for steam purposes and exportation, covers an area of 906 square miles. The railways are, in fact, now supplying the interior of England from 2875 square miles of coal field, as against 460 square miles, which is the extent of the coal field in Northumberland and Durham. The following coal fields have all been opened to the consumer by railway enterprise:—

	Square miles.
The Yorkshire coal field, including the Derbyshire and Nottinghamshire fields	760
The South Wales (Glamorganshire) coal field	906
The Lancashire coal field	217
The Somersetshire coal field	150
The South Staffordshire coal field	93
The North Staffordshire coal field	75
The North Wales (Denbighshire and Flintshire) coal field	82
The Gloucestershire (Dean Forest) coal field	34
The Warwickshire coal field	30
The Cumberland (Whitehaven) coal field	25
The Shropshire (Coalbrookdale) coal field	28
The Leicestershire coal field	15
The Forest of Wyre coal field (not fully explored).	

Mr. Charles Capper, in his admirable work on the "Port and Trade of London," gives the following account of the produce of these several sources of supply:—

The coals brought to London by sea come almost exclusively from the great north-coast coal fields of Northumberland and Durham. The south coast of England has also been, for the most part, hitherto supplied with these coals. The coals of Cumberland are chiefly exported to Ireland; those of Lancashire are mostly used in the manufactories of the district, except the canal coals from the collieries near Wigan, which have recently been sent to London by railway. Coals from the Derbyshire, Nottinghamshire, and Yorkshire coal fields, especially those from Clay Cross, in the first, and Barnsley in the latter mentioned county, have during the last ten or twelve years come into very large consumption in London, where they are received by railway. The North Staffordshire coal, which is by no means fully worked, is used in the Potteries, and the South Staffordshire in the iron manufacture. The Leicestershire and Warwickshire coals are coming into use in London, and are largely consumed in the counties to the north-west of the metropolis. The Somersetshire coals, worked in the neighbourhood of Radstock, form a valuable supply for the western and south-western counties, and will be more largely used when the district is more developed. The coals of Denbighshire, better known as Ruabon coals, are brought in some quantities to London by the Great Western Railway. The coals of South Wales, which is the largest field of all, are less generally known in the metropolis than almost any other. They are largely used on the spot in the iron manufacture carried on at Merthyr Tydvil, Ebbw Vale, &c., and in the copper smelting-works at Swansea. Some of the coals of this district, being semi-bituminous, have been pronounced the best in England for the purposes of marine steam-engines, and are, therefore, largely carried from Cardiff to London, Liverpool, Southampton, Portsmouth, and elsewhere, for the purposes of navigation. The quantity of coal in the South Wales coal field is immense. It is calculated that there are 16,000,000,000 tons of coal lying within reach. The quantity worked here in 1859 was 9,500,000 tons. Taking the production of future years at 10,000,000, the above-estimated supply would last for 1600 years to come.

The magnitude of the coal trade now conducted by the railway companies may be further illustrated by the fact that the whole quantity of coal exported annually from England to all the countries of the world is less than 8,000,000 tons, whilst the mineral traffic of the railways in 1863 exceeded 63,000,000 tons. Taking an average of 10s. per ton as the value of this coal when put into the trucks, we have 31,500,000*l.* as the prime cost of the article conveyed. The gross receipt from mineral traffic in 1863 was 4,957,406*l.*, or an average of 1s. 6¾d. per ton. Under proper arrangements it may be a question whether much of this mineral traffic could not be conducted at less rates than at present. But these proper arrangements of course include the construction of lines of road at much less cost than those on which the traffic is at present conducted.

The mineral traffic of railroads, large as it appears to be, is, probably, at present only in its infancy. Considerable fortunes have been, and are still in course of being made, in connection with it. And the field is so vast and so tempting that it cannot be doubted that with additional facilities additional capital and enterprise would be employed to develope the railway coal traffic of England.

A VISIT TO THE ZINC SMELTING-WORKS NEAR AIX-LA-CHAPELLE.

SILESIAN METHOD OF REDUCING THE ORES OF ZINC.

On the opposing sides of the narrow valley of the Munsterbush, about a mile from Stolberg Station, on the Aix-la-Chapelle and Cologne Railway, are two vast establishments for the reduction of the ores of zinc to marketable metal. A cloud of white fumes hangs above them all the week, and, as the condition of the atmosphere may happen to vary, rises in perpendicular columns toward the sky, or trails along the surface of the fields for many hundred yards, poisoning, as the peasants tell you with woeful countenances, all the cultivated plants that grow in its path. During the Sabbath this massive cloud melts away, and the bright sun falls strangely across the withered gardens, but still fleeces of frothy fumes fall from the mouths of the higher chimneys, proving that the great establishments only slumber to awaken into fuller activity on the morrow. On Monday morning we visit the westernmost furnace, to look with some care into the various succeeding processes employed, for here the zinc manufacture is carried to as high perfection as anywhere in this zinc-making country. The cloud of smoke has ascended high into the calm atmosphere, reddening the sun like the vapour from a volcano. The workmen are going to their labour with clean faces for once in the week, and heavy Flemish horses are drawing two-wheeled carts, laden with coal, from mines in the valley, over the well-paved road, to store-houses among the tall chimneys at the hill top. Passing through narrow streets, lined with the houses of miners and smelters, between which are wedged sooty blacksmiths' shops and small stores for dealers in cheap wares, and by the towering chimney of a coal mine, we arrive at the furnace of the Eschweiler Company, a series of low, but extensive, buildings enclosing a rectangular yard some 400 or 500 ft. on the sides. Glancing around, it is easy to recognise the laboratory, where the assays of ores and products are made; the department where clay is prepared, and the muffles and fire-brick manufactured; the roasting-house and the mill for grinding the raw ores to a powder, and, larger than all, the building for reducing the ores in which the furnaces are collected—a vast low tile-covered structure, 500 ft. long and 58 ft. wide. In addition to these, there are builings that serve to store ore, clay, and fuel in, and a smokey structure at the corner that serves for an office. Here we meet with the various officers, deliver our letter of introduction, and enter our name in the strangers' book, where are already two American names, and those of several Englishmen, among which the firm hand of Vivian, the great copper, zinc, and silver smelter, at Swansea, is conspicuous. The chief smelter kindly acting as guide, we pass from building to building, examining without restraint every process. First, to the large rectangular yard, where the ores, as received from the mines, are stored, surrounded by cordon of factories, furnaces, and store-houses; they are secure from disturbance. They are nearly all in the condition of fine powder, such as is formed by grinding and washing, and are piled in long pyramidal heaps 5 or 6 feet high. A thin bath of lime-cream has been thrown over them, which, consolidating into a hard scale, secures them against the action of the wind. In the side of each pile is stuck a small tablet, upon which is written the quantity, origin, and, when assays have been made, the constituents of the ore of which it is composed.

The larger quantity in store is blende, or sulphide in an unroasted condition, as brought from the various mines of lead and other minerals along the banks of the Rhine. The Eifel and the Westerwald have contributed their quota, and we recognise some of our old friends among the minerals from Siegen in Westphalia. There is a small pile from Spain—a carbonate and some poor lead-holding mineral from the vicinity of Stolberg. At one time some American calamine was sent them, but it was so poorly sifted, sorted, and washed, that they could not work it profitably. The blende, when brought to the furnace in large pieces, is first subjected to a complete grinding by passing it between revolving rollers. These rollers are arranged in two pairs, so that the coarser pieces are crushed in the first set, and all the ore that passes the second set of rolls and screens, is ground to a powder fine enough to roast properly. A steam-engine of 12-horse power moves rolls and screens. The powdered blende now comes to the roasting-house. Here 12 or 14 furnaces are employed converting the powdered sulphide of zinc into an oxide by subjecting it to an oxidising roasting. The furnaces are about 25 feet long, of the double-heathed reverberatory sort. The flame issuing from a common fireplace strikes along the lower hearth to the further end, where it rises up and comes back, spreading over the upper hearth to a point above that from which it started, where it makes its exit through a chimney about 50 feet high, which is built for about 40 feet at its upper end of heavy jointed clay tubes. The ore, brought from the yard in barrows, is wheeled to the top of the furnace by a movable bridge, in charges of about 1200 lbs. It is piled here, and when the proper time arrives for charging, is thrown by a hole in the arch upon the upper hearth above the fireplace. It is here spread, and allowed to heat for six or seven hours; then it is moved 5 or 6 feet further toward the hinder part of the furnace, and again allowed to remain six or seven hours, subject to the action of the flames; it is then moved again, until thrown upon the lower hearth, and moved by stages to the fire-bridge. This it reaches after six removals and intermediate roastings of six or seven hours, until, at the end of 36 to 42 hours, it is ready to be drawn out as a yellow or brown powder, containing, as the case may be, from 1 to 1½ per cent. of sulphur. This powder, in which the zinc exists as an oxide, is now deemed ready for charging into the crucibles for reduction, and is transported into the smelting department.

This building, the most extensive belonging to the establisment, occupies the eastern side of the rectangular yard. It consists of a single apartment, with numerous doors at the ends and sides. On one side are large coal piles, which are connected with various parts of the interior by a many-branched railway. At one end the cinder heap extends in a long embankment toward the valley. A railway from the interior is laid along its summit, and dusty cars continually transport the waste materials to the uttermost end. Upon entering the building the visitor has before him a vista of furnaces, extending onward until lost in the cloud of white fumes that fills the whole building. We enter at the hour devoted to clearing out and re-filling the muffles, and witness a scene of activity such as only exists at establishments using the Silesian method of reduction during five hours of the 24. There are 36 furnaces, containing 928 retorts, in this building. With but few exceptions, one furnace is but a counterpart of another. We will pass around through the dense cloud, which consists chiefly of the oxide of zinc—that substance which the old chemists knew as "philosopher's wool," and which is formed by the vapours of metallic zinc coming into contact with the atmosphere, taking on oxygen, and floating off as a fine powder. At every furnace, as we walk forward, we find three men; they are all very busy before the hot fires and glowing cinders, and some are naked to the waist, and streams of perspiration roll down their cheeks and sides. The peculiar white and greenish flame produced when zinc is burned, and the scarlet glow of the coal when seen through this flame, have at times all the striking effect of a pyrotechnic exhibition. At several of the furnaces a new muffle is being put in; for since a muffle lasts but 60 day, and there are nearly 1000 in activity here, an average of 16 to 18 must be renewed each morning. Sometimes a muffle has cracked, and a lambent flame is spouting out into the midst of the red coal flames of the furnace. This must be closed, if possible, and workmen are plastering the white hot vessel with clay by means of long iron paddles. But it is very rarely that this can be effectually accomplished, and when a muffle begins to leak it is usually deemed lost. In one corner a furnace built on the Belgian plan stands idle, it not having been found to equal the Silesian furnace, already in large use. In another, some experiments are being tried in purifying fine-grained zinc by fusing it with lead.

At length we complete our journey, and pause before one of the newest furnaces, which is just receiving the first attentions of the workmen, after some 20 hours inactivity. It is a furnace containing 30 muffles, 15 ranged on each side of a strong coal fire, one end toward the canal in which the fire is burning, the other towards the side of the furnace and the passage in which the workmen stand. The flames striking against the arch, which forms the covering of the whole apparatus, are thrown downward upon the ranges of muffles, and they are kept at a high white heat. Each muffle, or retort, is shaped like a huge thin hollow brick, about 5 feet long, 2 feet high, and 10 in. broad. The end towards the exterior of the furnace is left open, but after the muffle has been placed in the furnace, this end is built up with plates of clay, leaving two apertures—one below, from which the refuse can be drawn; the other above, into which is inserted a clay tube, through which the vapours of the reduced zinc distil. When the muffle is put into the furnace the lower hole is closed with a clay plate, and the charge is inserted through the upper aperture by means of a long scoop, or spoon. This charge consists of powdered ore and common bituminous stone coal, mixed in the proportion of about three by weight of the former to one of the latter. The charge consists of about 125 lbs., and the ore used produces from 20 to 30 per cent. of metallic zinc, while the proportion lost is even greater than this. The zinc begins to distil over in about half an hour, and coming into the tube, where a moderately cool temperature is maintained, it is condensed to a fluid, and drops into an iron pan prepared for it below. The heat is continued on this charge for 24 hours, when a new charge is introduced, and the operation continues.

The Belgian plan of producing metallic zinc from its ores is less popular in this part of Belgium than what we have above described as the Silesian system. The Belgian plan is in use in this country at Bethlehem. It requires less fuel but more muffles per hundred weight of zinc produced.

The following comparison of the two methods, made some years ago, will serve to show the cost in Belgium of producing the indispensable metal, which we import in such large quantities, and at the same time gives an idea of the comparative value of the two systems, when employed under the circumstances existing in the region about Aix la Chapelle, In reducing 2000 lbs. of calamine the cost was:—

	By the Silesian plan.	By the Belgian plan.
For muffles, or retorts	$0 18	$1 78
For bricks, iron, steel, tools, &c.	0 43	1 30
For coal	4 58	3 69
For wages	2 60=$7 79	2 84=$9 61

which shows an advantage of $1 82 on the side of the Silesian plan.

In the above calculation coal is reckoned at $2 20 per ton, and yet, at this low price, it will be seen rhat the fuel is the main item of cost in the reduction of zinc—a fact which shows the importance of locating a zinc furnace in the immediate vicinity of large and easily-wrought deposits of coal; a fact which one day will cause zinc ores to be imported from less-favoured lands to our own inexhaustible and accessible Pennsylvanian coal fields, here to be reduced to the metallic form.

—*United States Railroad and Mining Register.*

MINING AND SMELTING IN AUSTRIA—No. I.

TO THE EDITOR OF THE MINING JOURNAL.

Sir,—The mining operations carried on in Austria have, with the increase of financial facilities, the stimulus that has been given to manufacturing operations, and the introduction of late years of a large amount of English machinery for mining and metallurgic purposes, reached a point of development which is calculated to draw to them more attention in this country than they have yet received. Austria, unlike Russia, has made little effort to invite the investment of foreign capital in mining works; and, indeed, the remoteness of most of her great mines, even from her own capital, has discouraged both interest and enquiry. The civil disturbances in Hungary, one of the most promising of mining regions, have had their effect in diverting enterprise and capital. Yet the number of the mines, on a large and small scale, in which working is going on is surprising, and suggests the large amount of loss accruing from disassociated effort. Only a fraction of the Austrian mines are at present worked on the scale their returns would justify. Since 1852 the works at various mines and furnaces, which were carried on by different companies, have been combined, with favourable results. The reduction-works and rolling-mills have not unfrequently a separate ownership from that of the mines on the products of which they operate, but the amalgamation of the more important of these is evidently not far distant. Great distances and tedious, and therefore costly, transport between the great mines and the centres of manufacturing industry are the difficulties at present to be contended with. But further rich discoveries in the neighbourhood of new lines of railway are taking place; iron, lead, and silver crop out of valleys and plains, and on the tops of hills, where not a single pick has yet made its mark; and in the bars and shoals of numerous rivers and streams are deposits of crumbled tin, which would well repay the working. A sufficient number of labourers, gifted with natural aptitude for mining, is always at command.

To commence with Austrian gold and silver mining. This is chiefly carried on in Hungary and Transylvania. One of the most successful gold mines is at Saltsburg, in the chain of mountains which traverse the country from east to wast. At Felsobanga, in Transylvania, is a gold mine worked with great success, the ore of which is an auriferous sulphuret of silver in a species of jasper vein. Most of the rivers of Hungary contain gold. The river Moros has an auriferous sand deposited between two beds, neither of which have a particle of gold. The chief localities in Austria, and, indeed, in Europe, for mines of gold and auriferous sand are Shemnitz and Cremnitz, in Hungary. The gold of Shemnitz is accompanied by silver-lead and iron pyrites; the matrix is quartz. In Transylvania the gold mine of Nagyog is remarkable for gold combined with native tellurium. At the chief argentiferous iron and copper mines a method of extracting the silver by warm water has succeeded to the process of amalgamation. As soon as the powdered sulphide of copper and iron ore containing silver has passed, in a reverbatory furnace, into the condition of oxides, and the silver has just become a sulphate without losing its sulphuric acid, the process is arrested, and a mass of silver is obtained soluble in water, the rest of the ore being mainly insoluble. The process of lixiviation and precipitation is conducted in a series of tubs, in which hot water is the solvent. This water flows off into a reservoir where, after resting awhile, a large portion of the silver is deposited; the remaining water is now filtered off into a series of tubs on different levels, until, finally, all the silver is precipitated. Eight or ten days is given to the operation, when hydrochloric acid is employed as a purifier to lay hold of any mineral alloy in the deposit, such as oxide of copper. At some mines concentrated cupreous furnace products, containing silver are treated in the same way, with the difference of employing hot brine instead of water. In amalgamation, which in many localities is carried on, the sulphide having been converted into chloride of silver by roasting, this is mixed with mercury and some fragments of wrought-iron, and placed in revolving casks. The mass is kept in motion for about 20 hours—150 tons of mineral may thus be treated in 14 days. Every 5 tons requires 15 lbs. of metallic iron and 2 lbs. 12 ozs. of mercury. The silver produce of Austria may be set down at 150,000 lbs.; fourteen years since the yield was 87,000 lbs., which hardly exceeds that of 1845. The most valuable ore is a sulphuret of silver, in the mines of Shemnitz and Cremnitz, in Hungary, and Freyberg, in Saxony, where it is obtained in sufficient quantity to allow of working. The largest mines of argentiferous galena are those of Bleiberg and the neighbouring localities in Carinthia, where it is worked out from transition or mountain limestone, Freistritz, and other places in Styria, where, as in Freyberg, it is presented in veins of clay-slate.

The produce of the Austrian lead mines is not less than 12,000 tons per annum. The lodes in mines, both old and new, have been followed most perseveringly to immense lengths. Great sagacity is shown by the miner in striking again a vein that has dwindled away altogether, or struck off at some tangent. The lead mines where the most extensive works are carried on open out on the sides of hills, where the adit serves as a water-course. Much of the excavation is done by hand, pickaxe, and iron wedge; but gunpowder is also in constant use. A level is driven right and left in the lode, and the broken ore is conveyed by buckets to the surface. The main difficulty has been to keep the levels free from water. The pumping-engines of the Austrian mines frequently prove unequal to the task. A large number of English engines, of the Cornish type, have been recently imported. Unless the engines stationed at many of the lead and copper mines worked night and day they would be flooded.

Of the Austrian iron mines which claim the first attention is the great depôt of ore in the Mountain of Erzberg, between Eizener and Vordenberg, in Styria, from which the celebrated Styrian steel is manufactured. On the north and west side of this mountain rests a vast formation of sparry iron, constantly in course of crumbling, and precipitating from time to time immense masses on the plain below, a serviceable and economic provision for the neighbouring smelters. More than 2000 men are employed on this mountain. Much labour is expended in affording support, from the crumbly character of the formation, for the approaches to the embedded ore. Where gunpowder cannot with safety be introduced, fires are kindled against the sides of the mine, to make easier the process of detachment. The expense of working, viewed in connection with the abundant yield, is very trifling. The ore presents itself in beautiful brown, silky laminæ, and is much of the same character as that of the Bannat of Temeswar, in Hungary. As one emerges from the green level of the plains, this mountain rises in view like the bold and sterile rampart of some burnt upland, scarred on its face by the attacks of time, and the incessant labours of the miners, and pierced by arched corridors, the entrances to which appear unscalenble. The amount of rough travel daily undergone by the miners is almost unimaginable. Masses of iron pyrites, embedded in indurated slate or shale, are worked in Hungary and Bohemia. A micaceous iron ore is worked to some extent in the range of mountains that separate Austria from the Tyrol. At Amberg, in Bavaria, and in the iron mines of Hebeck, near Zbirow, in Bohemia, the ore is brown, and much injured by phosphoric acid. Its effect on the workmen, the acid taking the form of an exhalation, is very injurious.

Pyritous copper ore is the most abundant; it is found of immense thickness, accompanied by native copper, and yields all the varieties of arsenate of copper. It presents itself in limestone, in nearly perpendicular beds, and yields all varieties of arsenate of copper. The small size of the ore seams at many of the mines, seldom exceeding 1¼ ft. in thickness, renders the working arduous. In obtaining the copper, which presents itself as finely disseminated particles of the various sulphides, it it necessary for the miners to lie on their sides. Owing to the large proportion of silver in these bituminous seams, which are stratified like coal and slate, the fusion is easily and economically effected. The proportion of silver is usually ½ lb. for every 100 lbs. of copper schist. In burning the ores, care is taken not to drive off too much sulphur. The burning takes place usually on some high natural elevation; the foundation is of dried bundles of brush-wood, so arranged as to admit air to the centre of the heap, which is piled to a height varying from 7 to 10 ft., and a breadth of 30 to 40 ft., and a varying length according to the amount of ore, which is from 300 to 900 tons. The operation takes place in winter, as the blocks burn better when thawing gradually. Copper is produced in two forms—discs, adapted to casting, alloys, &c.; and refined copper, highly malleable, and prepared for market in ingots. To form rosettes, the blister copper is placed on a small German hearth, usually in quantities of 5 cwts., and covered with charcoal; a blast of air is then driven in, and is gradually strengthened, until the impurities can be separated as scoriæ, or driven off as fumes. The process lasts from four to five hours, and leaves the copper charged only with a considerable amount of suboxide. The depth of the colour of the fluid determines the amount of oxidation. The discs, usually three, are obtained by throwing successively cold water on the surface after the charge has been withdrawn. To produce copper with the malleability known as tough pitch, it is placed in quantities of 8 tons, on an inclined hearth, which instead of an arrangement for tapping, out of which the liquid metal may be ladled. The whole is then subjected to a strong heat, the slag being skimmed as it gathers, and the draught decreased, until with the admission of air, from numerous apertures suddenly opened, the oxidising process commences. To reduce the suboxide to metallic copper when a large quantity is in solution, the dry copper is covered with a layer of anthracite or charcoal, and a green branch of oak or birch is thrust in, which evolves gases, which produces sufficient commotion to bring the ore in half an hour in contact with the anthracite or charcoal on the surface. To concentrate the copper in a rich sulphide or coarse metal, the burnt schist is placed in a furnace in which the blast employed, and forced in with a powerful pressure, is 370° Fahr. In front of the furnace, hollowed in a bed of a mixture of clay and coke powder, are two basins, in which the slag ore and coarse metal run. To consume the bitumen in the schist takes from two and a half to four months; a strong wind, increasing the intensity of the heat, will hasten the operation, but in this case a solid mass, difficult to loosen, is apt to be formed, and the ore parts with so much sulphur as to require the blending of a highly sulphurised ore in the next smelting. Boards or small coal on the windward side are sometimes used as a protection against this casualty. The unique regularity of the cupreous deposits, and of the value and character of the ore in the chief mines of Hungary are remarkable, and have the advantage of requiring little variation in treatment.

Ehrenfriedersdorf, in Saxony, and Schlaggenwald and Zinnwald, in Bohemia, are famous for their tin mines. The tin occurs in the rock disseminated in minute veins, and the whole mass must be pounded before it can be smelted. Upwards of 1000 tons of tin, amounting in value to 75,000*l.*, is annually produced. The pyramidal tin ore is principally brown and black, and the ore commonly yields from 60 to 70 per cent. of the pure metal. The oxide of tin is met in veins traversing granite, gneiss, and mica slate, and occurs crystallised or fibrous, but rarely massive. The tin of Bohemia is compared to that of Cornwall, as the iron of Styria is to that of Sweden. The tin usually is accompanied by copper, and nearer the surface. Many of the abandoned tin mines of the Romans have thus yielded, on further working, rich stores of copper to modern miners. The alluvial debris of tin is found in the beds of numerous streams, and on being separated by washing has often yielded 70 per cent.; in some instances accompanied by veins of native gold. Native tin, in a state of oxide, or regularly crystallised, is roasted and treated in a flux to reduce the metals. After being roasted, it fuses readily with three times its weight of black flux, with a little decrepitation; the process is aided by the introduction of muriate of soda. At Kopnick, in Transylvania, and Chemnitz, in Hungary, tin accompanies copper pyrites, and is worked as an ore of copper—occasionally, also, for the silver it contains. C.

CANNOCK CHASE, AND ITS COAL MINES—No. V.

BY WILLIAM MOLYNEUX.

The Hednesford Colliery, as it is now known, originated with Messrs. Webb and Poxon, who sunk a small shaft to the 7-foot coal, and worked it at a depth of 48 feet from the surface. Some time afterwards, Messrs. Piggott and Co. became the proprietors, and in 1859 had extended a pair of shafts to the Brooch and Second coal, to which, so far, their operations have been confined. These two shafts are about 60 yards apart, and the sections they exhibit illustrate, in an interesting manner, the lithological diversity of the coal-bearing strata in the different localities of this important district. The shafts are on the line of dip which is here east-north-east, and as proved by the sinkings at an inclination of 1 in 90. They pierce ten seam of coal most of which, with the exception of those now in work, are thin and unimportant, the Brooch coal, 4 feet 2 inches thick, lying at a depth of 213 feet 4 inches, in the west pit, and 215 feet in the other; the succeeding, or Second coal, of 4 feet, being respectively 352 feet 9 inches and 354 feet 5 inches. The Brooch coal is used principally for domestic, the Second for furnace purposes, for which they are well adapted. No efforts have as yet been made to reach the deeper and better coals—the deep coal of the more southern parts of the field, with its accompanying ironstones, which, beyond a doubt, lie at no considerable depth below.

The Hednesford Pits are situated at the western extremity of a swelling hill, the northern face of which, as noticed before, forms the outcrop of from ten to twelve seams of coal and numerous lean beds of ironstone, especially at a point exposed by the railway cutting near the Cannel Pit field. The highest point of this hill is occupied by a farm, called Cooper's Lodge, adjoining which a well has been sunk through a bed of coal 4 feet thick, and at a depth of 14 feet from the surface. This is the top coal of the range, and lies, as seen by its outcrop in the field below, some 20 or 30 feet above that of the locally well-known Cannel coal. This last seam, worked in later times exclusively for private use, varies from 1 to 2 feet in thickness, dips to the west, and is much broken up by faults. Between this point, therefore, and the Hednesford sinkings it is evident, from the trough-like position of the strata, that a general dislocation of the measures has taken place, by which the beds on the west side have been thrown up and denuded; and there is every reason to conclude that throughout the whole distance from Hednesford to Radmore disturbing agencies have produced an enlarged series of fractures, which, in many instances, will be found detrimental to the success of ordinary mining. On the north side of this fault or outcrop, however, taking in the stretch of level between the Rawnsley and Castle hills, the rocks retain much more of their normal position, being nearly horizontal, and showing but little of disturbance or irregularity. It was over this area, which includes the Old Park and the New Hayes, that the old Beaudesert Collieries were dotted, and it is here that the most productive beds of this portion of the field are yet to be found.

So far as can be ascertained, none of the old shafts exceeded a depth of 105 feet, but they penetrated no less than seven different seams of coal; and when the former workings were abandoned a considerable portion of the area alluded to was still untouched. At 75 ft. the Smut coal, of from 4 to 5 ft., was worked, and at 30 ft. deeper another seam of 3 ft. 6 in., which was the best, and commanded the readiest sale, the potteries taking all that could be had in preference to any other. When the order was given for the discontinuance of these works headings had been driven for a distance of 150 yards in the deeper coal, beneath the New Hayes, but not a single load of the mineral thus laid open was, in consequence, brought to bank. I have been told by a very old man, who, as a collier, gleefully remembers the amount of beer ordinarily consumed by him at these pits many years before the advent of the present century, that at 66 ft. below the deepest coal then worked, and consequently 171 ft. from the surface, the deep coal of 4 ft. 6 in. was reached in boring by a man named Edward Hand, but no efforts were ever made to work the valuable bed which lay at a depth so convenient and accessible. The same authority also stated that he remembered his father speaking of Riley's Mine being worked under the name of "Duffer's coal," but that it was little cared for in comparison with the coal of the New Hayes. A very good coal, called the Waterloo coal, 5 ft. thick, was also opened up, at a depth of 24 ft., at Hazel Slade, under the Raunsley hills, and adjoining Bentley Brook, but the pit was filled in soon after the coal was won by Lord Anglesey's directions. One of the pits was sunk to 66 ft., and on one occasion a lad fell into it, but in his descent the smock-frock he wore became inflated, and thereby saved his life.

It was hinted in a former paper that there was every probability of coal being found at a workable depth on the east side of the great fault which brings in the New Red Sandstone. At the present time experimental borings are in progress at Brereton, through the Red Marl and Keuper beds, with the view of settling this important question, so far as it concerns the immediate district. The particulars of these borings will at some future time be made public, but it may be stated that the downthrow of the coal-measure rocks at this point is by no means so great as the character of the surface would appear to indicate. Several years ago similar experiments were made in a field adjoining the rolling-mill pool, near Rugeley, by Lord Lichfield, from which it is evident that the coal measures of the eastern margin of the fault extend north from Brereton some little distance, at least, beyond the supposed boundary line of the carboniferous rocks of this particular locality. How far this extension exists within the reach of human efforts is not easy to decide, but the few facts already established lead to the inference that the boundary of this coal field passes northwards far beyond the swelling and picturesque hills which constitute the northern and western limits of Cannock Chase.

The rolling-mill borings give a section of 418 ft. of the Keuper and Bunter beds, followed by red marls, sandstones, black shales, and ironstones, to a total depth of 612 ft. from the surface. At 545 ft. a bed of coal 13 in. thick was met with, reposing on a bed of fire-clay of 1 ft., succeeded by alternations of blue bands and other characteristic measures. At this depth the borings ceased, but it is to be regretted that a little more perseverance was not exercised in their management.

MINING IN IRELAND—No. XI.

[FROM OUR CORRESPONDENT IN THE COUNTY OF CORK.]

The Schull District.—For some time past there has been but little doing in Mount Gabriel Mine, in which there are several large and promising copper lodes; and although the mine has been partially opened in several places on the different lodes, the greatest perpendicular depth yet reached does not exceed 10 fms. from surface. Still these *superficial workings*, I am informed, have produced upwards af 500*l.* worth of copper ore. This mine has been recently inspected by a well-known and highly respectable and intelligent mine agent—Capt. Henry James, of Redruth, Cornwall. I have been favoured with a copy of his report, from which I make the following extracts:—

"The stratum in which the lodes are embedded is a compact schist, near the surface, and standing nearly perpendicular, which created in me a very unfavourable impression at first; but after examining the lode and strata at a greater depth, I found a great change in both, the schist becoming much softer, and dips at about the same angle as the lodes, and my opinion is that when the lodes pass into this lower stratum they will become productive. There are four east and west lodes, which have been partially explored, all of which near the surface produce copper ore, and as they go west they appear to come together at a point near the great cross-course, which can easily be traced for several miles from Cape Cleer northwards, through the gap of Mount Gabriel to Bantry Bay. I find by a survey made by Capt. W. Thomas, of the Schull Bay Mine, that by going back to the foot of the mountain 75 fms. an adit can be brought in 25 fms. deep. I certainly should recommend this to be done at once, and at the same time that a shaft be sunk from surface to meet the point where the adit will take the lode. This work will probably cost altogether nearly 1000*l.*; and I fully expect in carrying out this work—the sinking of the shaft 25 fms. deep—that sufficient copper will be raised to meet the whole expense of both the driving and the sinking, and will lay open copper ground that will leave a profit in the taking away after the shaft and the adit are communicated. This I believe to be the best plan of operations for thoroughly developing this mining property; and I do not hesitate a moment to recommend you to subscribe the above-named capital to carry it out. The produce of the copper is very good, as you will see by the assay made to-day—No. 1, selected specimen, 54½ per cent.; No. 2, ordinary specimen from the lode, 24 per cent. A large quantity of the carbonate of copper is also found in the joints of the killas, and also in the lode, a little distance off from the richest part of the copper runs; this will make a produce of about 4 per cent. It appears that some one interested in the mine fancied that by stamping and washing the carbonates he would be able to raise the produce, but in this, as a matter of course, he was mistaken."

The following are extracts from numerous reports of the late agent:—

"We have a good lode discovered, and for want of more men we cannot break it. There is a large pile of ore at surface, in a rough state, waiting to be dressed, and very few young mines present such prospects, with so little outlay. The lode is from 9 to 10 feet wide, composed of elvan, spar, light killas, carbonate of copper, and quartz, mixed with ore throughout, also containing branches of rich silver ore, from 2 to 4 in. wide. The deeper we are getting the more solid the ore is, and the more abundant. We ought to get 10,000*l.* for this mine, having the value in sight. It is a great pity there is not machinery on the mine to return the hundreds of tons of ore stuff, and dispense with costly hand labour. We are now raising splendid ore, and the mine is extolled in the district very much. It is the opinion of everyone here that it will make a good mine, and I am persuaded that my opinion will yet prove true, that this will make a rich mine, if vigorously worked. I am delighted to find the lode improve as we sink on it, which is a most important feature in a mine, and I believe I may say we are certain of success, and of having a profitable mine."

Now, making all due allowance for the probably highly coloured reports of the late agent of the Mount Gabriel Mine, yet when we read the report of a disinterested and experienced miner, like Capt. Henry James, is it not surprising that there should be any difficulty in obtaining capital to work a mine with such favourable prospects as are to be seen in Mount Gabriel? I do not wish by comparisons to disparage the mines of any district or country, but when we look at the millions of British capital lavished and lost in foreign schemes and bubble companies, it is really astonishing that capitalists will not look nearer home, and not only see what becomes of their money, but invest it where they may calculate upon fair and certain returns. I am well aware that a vast amount of prejudice exists against Irish mines; and, generally speaking, it is not to be wondered at, as large sums have been lost. The public, however, do not stop to enquire how, or in what way, the money was expended: but I think there would be no difficulty in proving that where capital has been invested to work *bona fide* Irish mines they have yielded good profits. The capital, however, appropriated by the "promoters of public companies" cannot, or should not, be put down as lost in Irish mines, simply because the mines never had the benefit of the outlay. A line, therefore, should be drawn between the amount of capital actually expended in the working of any mine, and the amount subscribed by the public, and we should then see, and the public also, that our mines present as good a field for the legitimate investment of capital as any portion of the United Kingdom. Let us select a few mines in this district, now working, to show that facts are better than opinions. The Roaring Water Mine, some 8 or 10 fms. deep, is producing splendid ore, and the vein stuff is all that could be desired in any mine. At Cappagh Mine the engine-shaft will soon reach the 94 fm. level: this shaft, a winze, and the skip-shaft are being sunk under the 94 fm. level on the course of the lode, which is producing rocks of ore intermixed with carbonate of lime, quartz, &c.: another cargo will soon be ready for market. Let any miner examine the ore coming up from the bottom of Ballycummisk Mine, and he would never doubt the existence of mines in the Schull district, or that the lodes would last in depth. The shaft is being sunk under the 114 fm. level. At Schull Bay Mine, in the engine-shaft, sinking under the 36 fm. level (62 fms. from surface), the lode is 6 ft. wide, and producing fine stones of ore, carbonate of lime, quartz, &c. The parallel south lodes will shortly be drained 36 fms. under previous workings, and which during a former working produced such a quantity of splendid malachite and rich ore. Many miners on a first visit to this district form an unfavourable opinion of it, from the fact of the surface slate rocks being nearly vertical; but when they go underground, and also examine the character of the rock brought up from 20 to 100 fms. deep, a total and favourable change in their opinions takes place, and nine out of ten admit that their first impressions were erroneous; at least, such has been the case with every miner I have seen in the county who was qualified to give an opinion, or whose opinion was worth having. The great slate formation of the Schull district is identical in character and composition with the slate formation of the Berehaven district. I have often examined them, and both the one and the other belong to the same formation. The similarity of the strata is so striking that a piece of the slate rock taken from the Berehaven Mine, or the Schull Mines, could not be distinguished one from the other.

Prof. Warington W. Smyth, whose authority I presume no one will have the hardihood to question, in his notes on the Berehaven Mine makes the following remarks:—

"The range of mountains which carries the Berehaven Mines on its extreme western slope, is a continuation of the lofty and broken ridge which divides the Bays of Bantry and Kenmare. It consists at this western extremity of slate rocks (the killas of the miners), and of some interstratified more massive beds, all of them highly cleaved. The cleavage planes are almost vertical, and crossing east 35° north. The dark blue varieties of the clay-slate are considered by the miners unfavourable to the production of copper ores, whilst the grey, and particularly the buff kinds, as in Cornwall and elsewhere, are held to be congenial. The "Mountain Mine," an extraordinary thick course of white, hard, wild quartz, runs in a rudely east and west direction, with a northerly underlie, through a rough mass of slaty and grit rocks, at an elevation of between 400 and 500 feet above the sea. For a length of above 100 fms. it is 50 to 60 feet in width, but by no means attractive to the eye of the miner, at a greater depth, the whole width of the lode, in despite of the unfavourable opinion which would have been passed on it at the surface by most miners, became impregnated with ore, and was, in some parts, worked to as much as 60 feet wide."

CORNISH MINING—BOTALLACK MINE.

[From Spargo's "Statisticts of, and Observations upon, the Mines of Cornwall and Devon," for 1863.]

Few who are unacquainted with mining would speculate upon the gigantic character of some of the Cornish mines, the amount of labour in several of which is represented by a sum that it is quite astonishing to contemplate, and some of which are undertaken in positions of danger enough to make the heart shudder. Amongst the most extensive, laborious, and dangerous of the Cornish mines may be reckoned the Botallack, commenced upon a granite cliff, upon which we have authentic history that the Atlantic waves have beaten for 20 centuries without producing any perceptible result, and which, with reference to geological history, presents features that quite surpass the human understanding: for example, the evidence is clear that millions of years before one lamina of the clay-slate was deposited the beautiful metal of tin was prepared in veins in granite for the use of man. The oldest of all the rocks, and the next in age, seem to have possessed the power or action of segregation of the metals, and collecting them into lodes At this early period it would appear that most of the lodes ran S.E. and N.W., and the currents of electricity, instead of travelling as they now do, ran 35° further to the eastward of north and westward of south; at least, this is the reading afforded by the district to which we now allude. It would, however, appear that the granite of this district is a disturbed granite, or, in other words, it does not occupy the site it used to do in the series of rocks forming the crust of the planet; the evidence of this is that the same lodes that are formed in the granite run into the clay-slate; a rock that must, from the nature of things, be many millions of years younger than the granite out of which it has been formed. The lodes that in the granite bear tin in passing into the slates are found to bear copper, and a curious metalliferous phenomenon appears to have taken place in the raising of the granite; for, following the ordinary geological law, the slates resting upon undisturbed granite and greenstone deposit lead, whereas the upthrow of the granite appears to have converted all the veins of the slate into copper lodes. Another astonishing feature in connection with these rocks is the power that lifted the granite, and for this, without taking into account the breaking strain, and calculating merely the lift in weight, supposing it to have existed at 10 miles of depth, would be 3 tons to the square inch, a power which, if under human control, could easily remove mountains. I suppose 10 miles may not be an absurd depth, as the clay-slates laid on the granites are found to be five miles in thickness, and these are broken and thrown about in all directions, as if they were only so much tinder or pumice: this shows the immensity of power lodged in the rock. If we put in juxta-position with this the human power as displayed in Botallack, we shall find that there is rock enough dug out of this mine to form a wall a mile long and 400 yards in height; but the money required to excavate this rock would build a wall of the same length, finding all the materials 5200 yards high, or upwards of three miles; while the money for the excavation of the mine would be represented by a sum about equal to half-a-million sterling. But the most startling thing connected with this immense work is, that it should have been undertaken under the bed of the ocean,—not a mere arm of the sea, but under the bottom of the great Atlantic, where its waters rave with unequalled fury. All its engines rest upon a foundation of never-failing granite, and its shafts are undertaken in that rock, but at some distance down under the bed of the ocean branch off into the clay-slate or killas, the Careg-glas or blue stone of the Celts. The engine-shaft was sunk perpendicular to a depth of 200 fms. or upwards from the cliff above the sea, and levels or tunnels 7 ft. high 4 ft. wide, were run out in the lode of copper under the sea for a half-a-mile under the ocean. It was then found that the broken ore, in order to get to the surface, had to traverse the base 400 fms. and pependicular 200 fms., of a right-angled triangle. Not liking this extra amount of labour and distance, the Cornish engineers concerned in the mine suggested the propriety of constructing a shaft which should form the hypothenuse to these two limbs: this has accordingly been accomplished, and the shaft by which the produce is now drawn to the surface forms an hypothenuse to the perpendicular engine-shaft from the surface to the point of the base or railway from its bottom running out under the Atlantic, as we show in the accompanying section, for which we are indebted to the manager. To give an idea of the power engaged under human control, but apparently entirely above human power in its immensity, we may state the wood rod from the end or nose of the beam to the bottom of the engine-shaft is upwards of a ¼ mile in length. We are not in the habit of seeing rods of this length, and for the moment can only form an inadequate notion of their extent, but a rod 14 in. square and 1200 ft. long cannot be a light article. We may, perhaps, give a more adequate idea of the power of those engines by supposing a room 12 ft. square and 9 ft. high. Now, if you suppose this room to be represented by a block of granite a cube of the size mentioned, containing 1296 cubic feet of solid stone, and if you supppose this monstrous block of granite chained by strong chains to the nose or the end of the beam, this would be the weight that this modern sysypus has to lift up 10 or 12 ft., and lower down again continually three or four times a minute throughout the day and night: or supposing a horse could draw up a pulley attached to a rope 2 cwts., this machine would lift as much as 1000 of such horses, and that for a distance of about 25 miles in 24 hours. A popular writer, describing his sensation on visiting these mines, says, "Standing below the cliff, and looking up from the sea, the view is fearfully grand, and remarkable for the combination of the wonders of art and the wonders of nature. On the very summit of the beetling cliff you behold mining apparatus overhanging the sea, you see a chimney smoking loftily at the top, and another puffing less loftily about half-way down; then, lastly, closer to you, and almost close to the sea, is a third smoking chimney, connected with a small mining office. On the one side of the cliff tall ladders enable the miner to ascend; and he must have a sure foot and a strong head who can comfortably tread those ladders round by round, the sea roaring under him, and almost flinging its raging spray after him as he

gets higher and higher. Taking in the whole apparatus at one view, chains and pulley-chimneys and cottages, posts and winding machines, scattered over the face of the whole cliff, like the spreading lines of an immense spider's web, while in some places mules and their riders may be observed trotting up and down the rocky tracts that the pedestrian visitor would scarcely dare to venture upon. You turn dizzy, and even faint, in looking up at them. You give your fancy wing for a moment, and you think you see a company of spirits belong to the ranks of the powers of the air, who, for the special purpose of mocking poor fettered man, are scaling precipices, and dancing on rocky needles, and skipping up fancy ladders, and snorting and puffing from the hidden fires, and disemboweling the martyred earth, and forging thunderbolts, and diving suddenly under the indignant hissing ocean, and spiriting away hidden treasures, and punishing a host of poor culprits by imposing upon them incessant labour, amidst unearthly peril and unearthly companions." Far down under the level of the sea you may find the patient miner with his pickaxe and gad or wedge, or with his auger or borer drilling holes into the purple shining and variously hued copper, which between two walls, some 4 ft. more or less apart, occasionally yields 200*l.* worth of this precious ore to the fathom, or 4 square yards to the width of the vein or lode, and very often such an amount of copper (say, 200*l.* worth) would be obtained for a labour cost of 3*l.* or 4*l.* This mine has been worked in stages, with reference both to time and the deepening of the works under the Atlantic, and to one set of adventurers alone it left or gave a fortune (300,000*l.*) Thirty years ago a friend of the writer, who visited the 130 fm. level of this mine, found such a lane or course of copper ore as described. The copper of this mine is often a dull, heavy bell-metal colour, and the miners call it horseflesh copper ore; it also appears to form small bladders on the surface of the stone, and hence the miners call it blistered ore. The mine is now paying about 30 per cent. upon the capital, having paid 1400*l.* in dividends in August last; and although at a considerable depth under the sea the mine is still considered a healthy investment, and worthy of the capital of any person investing in mines. The dividends declared have been 469*l.* 15s. per share, or 100,000*l.*, to the present holders; the capital expended to obtain these results was about 20,000*l.* The mine is divided into 260 parts or shares. Let no person lightly condemn the intention and labours of the miner, but, from a contemplation of this great work, let those who are in the habit of decrying miners and mining learn to estimate this calling at its proper worth, and endeavour by all legitimate means to promote it, or we may rest assured that should this great branch of the natural industry of this great country cease to flourish the fortunes and weal of the nation will perish with them; but a business surviving 23 centuries of the changes to which commerce is subject cannot be easily extinguished. A scientific writer says such a mine, so beautifully described by Job, is certainly no less wonderful than the Pyramids of Egypt, which it equals in size; but the one was built at the cost of human life on the tomb of a mummy, the other dug for the benefit of an entire country. Incredible is the toil; 20 or 30 men could excavate only a few inches daily of the galleries or shafts, which now extend under miles of land and ocean. Such is the result of perseverance, under proper influence, with a suitable object in view

STEAM-BOILER EXPLOSIONS.

At the monthly meeting of the executive committee of the Association for the Prevention of Steam-boiler Explosions, held at the offices, Corporation-street, Manchester, on Tuesday, Mr. L. E. Fletcher, chief engineer, presented his report, of which the following is an abstract:—"During the past month there have been examined 300 engines and 440 boilers. Of the latter, 32 have been examined specially, 7 internally, 31 thoroughly, and 370 externally, in addition to which 2 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 6 (1 dangerous); corrosion, 18 (2 dangerous); safety-valves out of order, 8; water-gauges ditto, 19 (4 dangerous); pressure-gauges ditto, 14 (1 dangerous); feed-apparatus ditto, 5 (1 dangerous); blow-out apparatus ditto, 43; fusible plugs ditto, 4; furnaces out of shape, 5 (2 dangerous); over-pressure, 3 (3 dangerous); blistered plates, 2: total, 127 (14 dangerous). Boilers without glass water-gauges, 11; without pressure-gauges, 2; without blow-out apparatus, 13; without back pressure-valves, 43. The three furnaces reported above as out of shape, all became so from overheating, consequent upon shortness of water, the injury in each case being observed for the first time, on setting to work in the morning, after the boiler had been standing during the night with the fires banked up, while two of the cases of injury were first observed on a Monday. Each of the boilers had but a single glass water-gauge, two of which were of the pillar construction, while all the boilers were fitted with fusible plugs, which proved inoperative in every instance. One of the boilers was fitted with a fusible plug in each furnace, both the crowns of which came down; the second was fitted with a fusible plug in the right-hand furnace only, and that was the one injured; while the third was fitted with a fusible plug in the left-hand fire-box, and the right-hand was the one injured. But in neither case did the fusible metal melt or give any sign. There are several ways in which the water supply may run short in a boiler left standing for the night with the fire banked up, all of which should be guarded against. Where there is only a single glass gauge, the attendant may be deceived as to the actual amount of water in the boiler, and thus the supply be left short overnight unawares. It is well, therefore, to add a duplicate gauge, so that one may act as a check upon the accuracy of the other; this would frequently prevent mistake.

Again, leakage may occur at the feed back-pressure valve, or at the blow-out tap, either from their being in bad condition or imperfectly closed. Enginemen are not sufficiently alive to the importance of examining these as a precaution, but leave them untouched until proved to be actually defective; whereas the feed back-pressure valve should be frequently taken out, and its free action ascertained; while the blow-out tap also should be examined, the plug cleaned and greased, as well as ground up, if necessary. A considerable safeguard also to furnace crowns would be found in a low-water safety-valve, which lets off the pressure of the steam on a deficiency of water occurring within the boiler. It may be true that it would not necessarily prevent the furnace crowns from becoming overheated, since the fire would go on burning, if left to itself, after the water supply had run short; but as the valve would not admit of any accumulation of steam, the injury would be confined to the plates over the fire; unless, by excessive carelessness, the attendant should let in the water and get up steam in the morning without observing the distorted furnace-crown. Such, however, could not occur without the most culpable blindness, against which it is impossible to provide.

Explosions.—Five boilers, not under the inspection of this Association, have exploded during the past month, from which eight persons have been killed and four others injured. Three of the boilers have been personally examined since the explosion. The following is the monthly tabular statement:—

Tabular Statement of Explosions from Sept. 30, 1863, to Oct. 23, 1863, inclusive:—

Progressive No. for 1863.	Date.	General description of Boiler.	Persons killed.	Persons injured.	Total.
33	Oct. 1	Balloon, or haystack. Externally fired	1	1	2
34	Oct. 2	Details not yet ascertained	5	1	6
35	Oct. 6	Ordinary single flue, or "Cornish." Internally fired	1	0	1
36	Oct. 20	Locomotive	1	2	3
37	Oct. 22	Ordinary single flue, or "Cornish." Internally fired	0	0	0
Total			8	4	12

No. 33 Explosion.—The particulars of this explosion may be briefly told. The boiler, which was not under the inspection of this association, was the outer one of three working side by side, and connected together, all of them being of the balloon, or haystack class. Each of these boilers was of a large diameter, the one in question being about 18 feet at the base, the sides swelling to a still larger diameter at the springing of the hemispherical domed top. The bottom, which was arched, but had no stays to tie it to the crown, was worked into the sides by the plates being bent, and was seated upon a circular kerb of brickwork. Each of the boilers was fitted with a single safety-valve, of rather a rough description; while it was stated that the working pressure had not exceeded 5 lbs., but that the exploded boiler, which was twenty years old, had already been repaired several times. Immediately over the brickwork seating, the plates for some distance round the boiler had been seriously affected by external corrosion, and reduced in places to one-eighth of an inch in thickness. It was from this cause that the rent occurred, the rent running circumferentially for a distance of 10 or 12 feet, parallel with the seating, and for the most part through the body of the plate. A portion of the bottom was blown down into the ashpit, where it remained, the rest of the shell flying to a distance of about 70 feet, across a public road adjoining, and carrying away a portion of the boiler shed in its flight. The engineer, as well as another man lying near to the boiler at the time, were both scalded, the latter dying shortly after in consequence. Competent inspection could not have failed to detect the dilapidated condition of the boiler; while this explosion shows that, however moderate the pressure may be, no boiler can be safely worked unless frequently submitted to a searching examination.

No. 35 explosion, from which one person was killed, arose from the collapse of the internal flue of a plain Cornish boiler, which was not under the inspection of this association. The diameter of the shell was about 5 ft. 6 in., that of the flue 3 ft., the length of both 28 ft., the thickness of the plates generally ⅜ of an inch, but in the flues barely as much, while the steam-pressure was 45 lbs. per square inch. The collapse had extended from one end of the flue to the other, the portion over the fire being the least affected, while the remainder behind the bridge was completely flattened down. The boiler had not, however, stirred from its seat, or broken a steam-pipe joint, and all that was needed to resume work with the other two boilers, to which this was connected, was to close the junction valve. A rupture in an externally-fired boiler would have led to the dislocation of the whole series. The damage done by the last explosion of a boiler of that class was nearly 1000*l.* The cause of the explosion in question was obvious—weakness of the flue. No flue of such dimensions as those just given can be safely worked with steam of a pressure of 45 lbs. on the square inch, unless strengthened either with hoops or flanged seams, or stayed in some other suitable manner. It may be true, however, that some such flues, though unstayed, are working, and have done so for years, with steam of an equal or even a greater pressure than the above; still they are continuing to do so only at a risk, and their past immunity from collapse is no security against its occurrence in the future. Some flues gradually work themselves out of the circular shape, and thus become considerably weakened; while all should be placed beyond the suspicion of danger, especially as this can be done at so trifling an expense. For particulars of the best method of adding hoops to those flues which are already made, see the Association's Monthly Report of June, 1862. The fireman who was killed was standing in the front of the furnace at the time of the explosion, and blown, rake in hand, to a distance of about 60 ft.

No. 37 Explosion occurred to a Cornish boiler with a single flue, internally fired, and not under the inspection of this association. Fortunately no one was injured, the explosion occurring during the dinner-hour, when the men usually working near it were all absent. The boiler was set on two side walls. It was 23 feet long; its diameter in the shell was 6 feet, and in the furnace 3 feet 6 inches, which was reduced behind the fire-bridge; while the thickness of the plates was 7-16ths of an inch. The simple cause of the explosion was external corrosion, the plates having been so eaten away as to be reduced to 1-16th of an inch in thickness. Two complete belts, the entire circumference of the boiler, and a plate wide, had severed themselves from it; while a third, which had rent in a somewhat spiral direction, and considerably overlapped a single circumference, lay opened out, and still attached to the shell. The two detached belts had fallen, one on each side of the original position of the boiler, doing considerable damage to property thereby; while the main part of it had moved but slightly from its original seating, although it had made a semi-revolution on its longitudinal axis, and lay bottom upwards. The chimney was shattered; the boiler-house, as well as an adjoining building, demolished, and some heavy machinery dismantled.

Treating Mineral Oils.—Mr. H. Fehr, of Fenchurch-street, proposes first to take a certain quantity of petroleum, and add a certain portion of lime or chloride of lime, and then add acid. He allows the gas to act on the oil until the latter has acquired the necessary quality and the desired smell. This invention received provisional protection only.

Thames Tunnel Company.—Receipts for the week ending October 24, 69*l.* 2s. 10d.; number of passengers, 16,594.

IMPROVED ORE BREAKING MACHINE.

The very powerful ore-breaking machine, to which we directed attention during the recent International Exhibition, has now been subjected to severe practical tests, and has fully realised the favourable anticipations we entertained of it. We expressed our conviction that it only required to be known in this country to be appreciated and very generally introduced, and we now find that Mr. Marsden, of the Soho Foundry, Leeds, who has undertaken their manufacture here, has received very satisfactory testimonials from those who have already adopted them. One of the machines has been started at the Cornubia Tin Mines, St. Austell, during the past week, and no doubt is entertained of its giving equal satisfaction to that which has been for the last six months in successful operation at Dolgelly. We understand that Mr. Marsden has already sent out upwards of 20 machines to California, and the invention has likewise been introduced upon the gold mines of Australia. It has had fifteen months' trial at the Lake Superior Copper Mines, and a great saving of labour has resulted. It is stated that mines that did not pay now yield good profits; that the breaker does not take a quarter the power required for stamps, and that one machine will crush more ore in 10 hours than a dozen stamps. The machine may be described as a crushing-hopper, the hopper, in fact, being the portion of the machine in which the crushing is effected; its object is to break stones into small fragments, to be used for road-making, railroad ballasting, concrete, or other purposes, and to crush ores or minerals of any kind; and its great recommendation is that it is simple and compact, portable, and being complete in itself, requires no support, fixtures, or foundations whatever. The principle of the machine is easily understood: one side of the hopper is formed of a vertical block of iron, the opposite side being a lever or movable jaw, suspended from above the cheeks; it is within the chamber thus formed that the stone or mineral is crushed. The fixed jaw is connected by the sides of the machine with the toggle-block, and, according as the toggles are straightened or otherwise, the movable jaw is given a backward or forward motion; the crushing power is given by straightening the toggles. This straightening is thus effected; the driving axle is connected with the long arm of a lever, the short arm bearing upon a fulcrum, formed of a cross-piece in the frame of the machine—with this lever the toggles are connected by a stout rod; every upward movement of the main lever causes the straightening of the toggles, and, consequently, the closing of the jaw upon the rock to be crushed, a powerful spring behind the jaw aids its return after each forward motion.

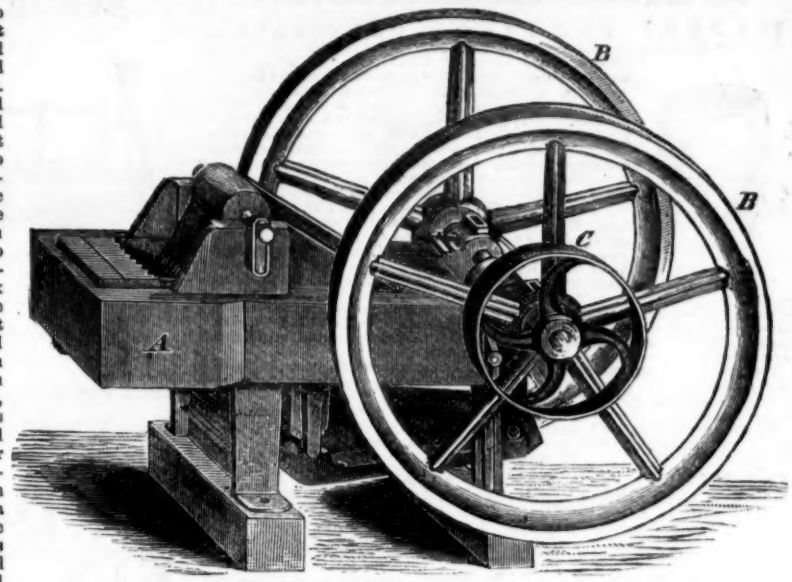
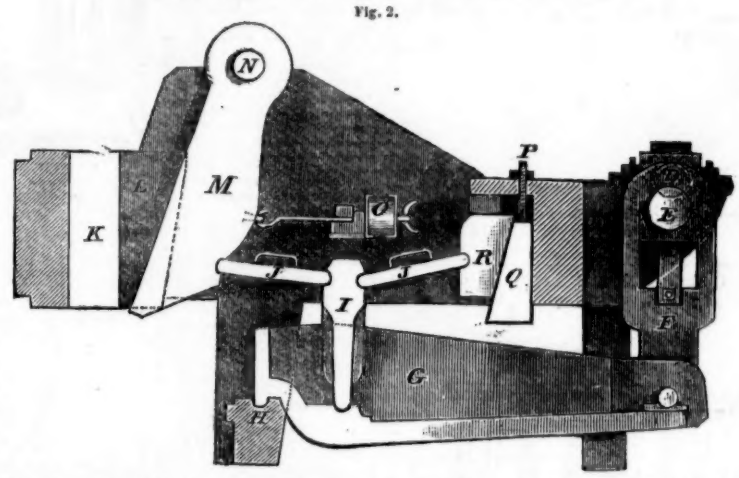


Fig. 2.



As there are, doubtless, instances in almost all mines where the machine would be extremely valuable to miners, we give the diagrams of the perspective view of the machine and of the machine in section, in order that it may be thoroughly understood in all its details. Fig. 1 is the perspective view of the machine entire. The frame, A, which receives and supports all the other parts, is cast in one piece, with feet to stand upon the floor or on timbers. These feet are provided with holes for bolts, by which it may be fastened down if desired, but this is unnecessary, as its own weight gives it all the stability it requires. B B are fly-wheels, on a shaft which has its bearings on the frame, and which between these bearings is formed into a short crank. C is a pulley on the same shaft, to receive a belt from a steam-engine or other power. Fig. 2 is a section of the machine. The parts of this figure which are shaded by diagonal lines are sections of those parts of the frame which connect its two sides, and which are supposed to be cut asunder, in order to remove one side, and present the other parts to view. The dotted circle, D, is a section of the fly-wheel shaft, and the circle, E, is a section of the crank. F is a pitman or connecting, which connects the crank with the lever, G. This lever has its fulcrum on the frame at H. A vertical piece, I, stands upon the lever, against the top of which piece the toggles, J J, have their bearings, forming an elbow or toggle-joint. K is the fixed jaw, against which the stones are crushed. This is bedded in zinc against the end of the frame, and held back to its place by cheeks, L, that fit in recesses in the interior of the frame on each side. M is the movable jaw. This is supported by the round bar of iron, N, which passes freely through it, and forms the pivot upon which it vibrates. O is a spring of India rubber, which is compressed by the forward movement of the jaw, and aids its return. Every revolution of the crank causes the lower end of the movable jaw to advance towards the fixed jaw about ¼ inch and return; hence, if a stone be dropped in between the convergent faces of the jaws, it will be broken by the next succeeding bite; the resulting fragments will then fall lower down and be broken again, and so on until they are made small enough to pass out at the bottom. The readiness with which the hardest stones yield at once to the influence of this gentle and quiet movement, and are brought down to the required size, may be judged of from the fact that Mr. John Oakey, of the Wellington Emery Works, Blackfriars-road, certifies that he has had the machine in use for nine months, and finds it a very useful machine—simple and compact in structure, and sufficiently powerful to crush any piece of emery stone that will enter the jaws; all other stones are comparatively soft to emery.

It will be seen that the distance between the jaws at the bottom limits the size of the fragments. This distance, and consequently the size of the fragments, may be regulated at pleasure. A variation, to the extent of 5-8ths of an inch, may be made by turning the screw-nut, P, which raises and lowers the wedge, Q, and moves the toggle-block, R, forward or back. Further variations may be made by substituting for the toggles, J J, or either of them, others that are longer or shorter than those in use.

It is obvious that the yields per hour, in cubic yards of fragments, of all crushing machines will vary considerably with the character of the stone broken. Stone that is granular in its structure, like granite and most kinds of sandstone, will pass through more rapidly than that which is more compact in its structure; but with material of the hardest kind a machine with a hopper, 20 inches by 7 inches, and driven by an engine of 5-horse power, will yield about 8 cubic yards, or between 9 and 10 tons weight of stone per hour. The description of stone being the same, the product per hour will be in proportion to the width of the jaws, the distance between them at the bottom, and the speed. The proper speed is about 200 revolutions per minute; and to make good road metal from hard compact stone, the jaws should be set from 1¼ to 1½ in. apart at the bottom. For softer and for granular stones they may be set wider. The machine is considered to be the most efficient one yet introduced for the crushing of hard material, such as iron, lead, tin, or copper ore, quartz, &c.; whilst it has the advantage, that it takes in larger pieces than any other machine, and, with less power, reduces them to the required size.

Gun-Cotton.—Immediately after Prof. Schoenbein published his discovery of gun-cotton, numerous experiments were made with it in France by order of the Minister of War; but the result was rather unfavourable. Recent experiments, however, made in Austria, now tend to bring this explosive substance into favour again; and some interesting papers were read on the subject at the last meeting of the British Association at Newcastle. We now find some further remarks on gun-cotton, by M. L. Von Karolyi, in "Poggendorff's Annalen," a well-known German scientific periodical. From this we learn that the gun-cotton manufactured according to the method of Major-General Baron Von Lenk, a distinguished officer in the Austrian service, at Hirtenberg, near Wiener Neustradt, has been successfully used in mining operations by the Corps of Engineers, and also by the Artillery, although there are still some difficulties in the way of its general adoption. From the experiments made by the Austrian Committee of Engineers, of which M. Von Karolyi is a member, it appears that the gases generated by the explosion of gun-cotton contain by weight 28·92 per cent. of carbonic acid; 30·43 of carbonic oxide; 6·47 of marsh gas; 9·89 of bi-oxide of nitrogen; 8·71 of nitrogen; 1·60 of carbon; and 14·28 of aqueous vapour. The gun-cotton manufactured by Baron Von Lenk is far superior to that employed in the French experiments, because he uses various precautions which had not then been suggested; thus, the acids he uses to dissolve the cotton in are of the very best quality, and the immersion is repeated twice. He has further proved that gun-cotton, when not compressed, and quite free in the open air, produces no useful effect by its explosion, but that when compressed within a small space, its effect is far more violent than gunpowder; and that, moreover, the compression may be regulated so as to produce any amount of force, from the maximum down to the value of a pound weight.

Improved Coal-Cutting Machine.—Mr. Delahaye, of Rouen, proposes an apparatus, which consists of a frame, or frames, adjustable to height or length, with the two ends capable of being caused by the pressure of a screw to hold firmly against the top and bottom or partition walls of a mine, or other cavity to be excavated. The frames form guides for slides worked by means of a lever and rachet, and a pulley with a cord round it, such slides having connected to them, by means of suitable cross-framing, the carriage for the travelling tool, which carriage is supplied with holes for the insertion of a forked bar, or bars, by means of which the carriage may be worked as required along the cross framing, friction rollers being applied to the carriage in order to facilitate its motion thereon. By means of the foregoing arrangement of apparatus, the operations of the workman will be made to consist in guiding the travelling tool, which will work after the manner of a plane, whereby he will be relieved from the more trying operation of working as usual with a pick.

Manufacture of Tin and Terne-Plates.—Mr. G. Tomkins, of Morriston, Glamorgan, has patented an invention which consists of certain improvements in the manufacture of tin and terne-plates, and in the apparatus used therein, the object being to make the plates with greater rapidity and of better quality than by the methods at present in use. He proposes to coat iron-plates with tin, or with a mixture or alloy of nickel, zinc, and lead, or entirely with lead. To make tin-plates, he proposes to dip the iron-plates into the pot, and then draw them upwards through brass or other metallic tubes, rollers, or bars, instead of leaving them in the grease pot. In order to do this he arranges on the top of the metal pot an oblong square frame, placed horizontally, holding from two to two dozen clams, rollers, tubes, or bars fixed on the top of the pot. A lifting rack at the bottom of the pot will raise the plates, after which they are to be caught with a clip and removed. The clams may be made hollow or flat, either in the form of circular or square tubes or flat bars, and are to be kept heated at a temperature equal to that of the molten metal below them by means of mandrils or rods heated by immersion in the molten metal or in a fire, and then inserted into the hollow clams, or by means of molten metal circulating through the same, or, when bars are used, by dipping or lowering them into the metal. Gas may also be employed to heat the clams. The distance between the clams can be regulated according to the thickness of the plates to be drawn through them. These clams partially clear the plates from the superfluous molten metal instead of using the ordinary grease pot; they will also answer the purpose of cleaning the plate from the list instead of using the list pot. For lead and terne-plates he proposes to use the clams, but in lieu of dipping the iron-plates into the molten metal, he proposes to form above the clams a tray, three sides of which form a gutter or channel for carrying the molten metal, which is ladled from the pot into the gutter. The iron-plates are held in a rack below the tray and above the pot, they will be raised up through the clams by means of clips after the molten metal has been poured into the tray above them. From each end of the gutter a series of tubes, from two to two dozen, communicate, through which the metal runs, and passes out through narrow slots cut along the sides of the pipes or tubes, by which means the metal runs down the sides of the iron-plates and coats them, and the clams clean and draw the superfluous metal therefrom instead of using the grease pot or hot chamber, as is now done. Sometimes he tins the plates by a circular rack. The plates are first to be dipped in hot water after coming from the cold water; in consequence of the plates being dipped into the hot water they become dried; then they are to be dipped into liquid spirits of salts and sal ammoniac water, instead of dipping them into grease; they are then placed in a sliding rack; the rack is then brought over the hot plate of the pot to dry them, and they are then placed in another dipping rack, and immersed in the molten metal, they are then removed and cleaned as before. Or, instead of the sliding rack, he proposes to place the plates to be coated into a circular or revolving rack, half of which rotates in the molten metal. A cap extends around the rack, or nearly so, in order partly to enclose or confine the heat within the various divisions of the rotating chamber, and also partially or wholly to clean the plates, a shifting ring or band also encloses the divisions, and prevents the plates from falling out of this rack. In some cases he dispenses with the cap or cover, and substitutes the clams in the form of rollers, tubes, or bars, as above described, which are placed above the circular rack in a horizontal position. The plates are then drawn through the rollers, bars, or tubes, and cleaned, as before stated. In some cases he uses a series of double or open arms set on a shaft worked by a winch, crank, or other means, upon and between which on pins a corresponding series of racks are suspended, in which racks the plates to be coated are held; the shaft is set above the pot in suitable bearings, and underneath the rollers or clams; the revolution of these arms causes the plates to dip into the molten metal, whence they are lifted and drawn through the rollers, bars, or tubes, and cleaned accordingly. In making tin-plates he uses a brush or brushes below the clams, for the purpose of cleaning the plates of the superfluous metal previously to their passing through the clams, but for lead and terne-plates the rollers, clams, tubes, or bars are to be adopted, and will be found sufficient. These may be made of brass, copper, steel, or iron, or other metals or alloys. The circular rack may, in some cases, be employed for the manufacture of lead and terne-plates. A great advantage will result from the manufacture of terne-plates composed of iron dipped in the mixture of ½ a part of nickel, 3 parts of zinc, and 112 parts of lead, or thereabout. Perhaps the greatest advantage of the invention is that several dozen plates may be made simultaneously instead of only one plate, as is now done.

Speed of Steam-Engines.—Referring to the announcement that an ingenious Frenchman has invented a means of considerably increasing the speed of the steam-engine, but more especially marine-engines, a correspondent of the *Western Times* says—"I should like to have the opinion of practical men whether it is not possible to effect the same object by attaching the piston-rod to a small-toothed wheel, instead of to the large driving-wheel as at present adopted, the teeth of which could work in the axles of the driving-wheel. By this means I am inclined to think a considerable saving of power might be accomplished, as well as the attainment of a much greater speed."

Dangerous Suggestion.—Some writer in the *Bristol Mercury* suggested the use of limestones for fuel, whereupon an unhappy wight who tried them writes to give the result:—"In about a quarter of an hour," he says, "nearly the whole contents of the grate were blown out into the room; it burnt the carpet seriously, and broke two panes of glass in the window, besides frightening the children into fits, and my poor wife has miscarried, and been under the doctor dangerously ill ever since."

Prize Medals—International Exhibition, Class 1 and 2.

PATENT PLUMBAGO CRUCIBLES.—

The CRUCIBLES manufactured by the PATENT PLUMBAGO CRUCIBLE COMPANY are the ONLY KIND for which a MEDAL has been AWARDED, and are now used exclusively by the English, Australian, and Indian Mints; the French, Russian, and other Continental Mints; the Royal Arsenals of Woolwich, Brest, and Toulon, &c.; and have been adopted by most of the large ENGINEERS, BRASSFOUNDERS, and REFINERS in this country and abroad. The GREAT SUPERIORITY of these melting pots consists in their capability of melting on an average 40 pourings of the most difficult metals, and a still greater number of those of an ordinary character, some of them having actually reached the EXTRAORDINARY NUMBER of 96 meltings. They are unaffected by change of temperature, never crack, and become heated much more rapidly than any other crucibles. In consequence of their great durability, the saving of waste is also very considerable.

The company have recently introduced CRUCIBLES SPECIALLY ADAPTED for the following purposes, viz.:—MALLEABLE IRON MELTING, the average working of which has proved to be about seven days; STEEL MELTING, which are found to save nearly 1¼ ton of fuel to every ton of steel fused; and for ZINC MELTING, lasting much longer than the ordinary iron pots, and saving the great loss which arises from mixture with iron.

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Fully described in the Mining Journal of July 5.

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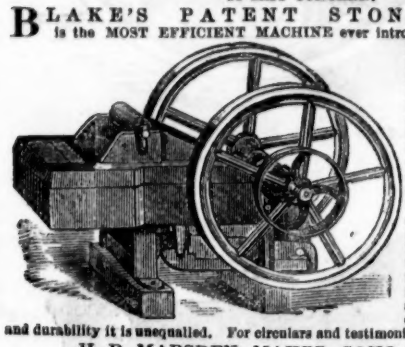

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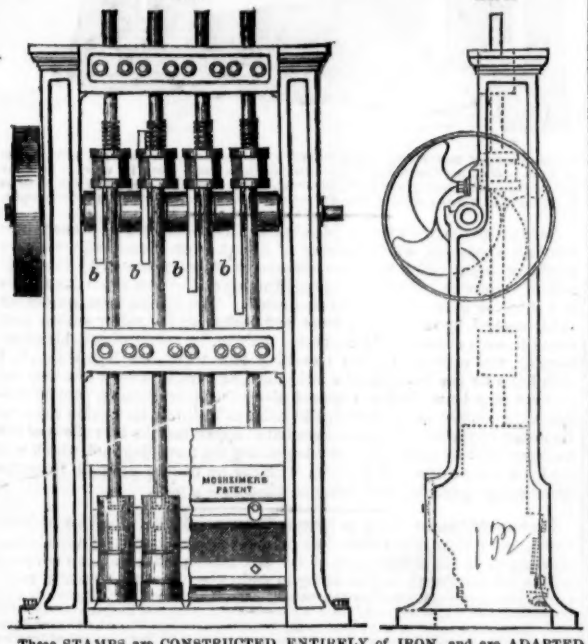

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152

MINES AND MINING.

STATISTICS OF AND OBSERVATIONS UPON THE MINES OF CORNWALL AND DEVON.

Illustrated by Maps, Plans, and Sections of the Principal Mining Districts in the two counties. By Mr. THOMAS SPARGO,

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154

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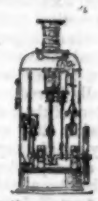
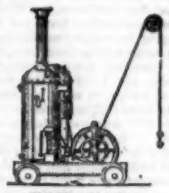


Stationary Engine.

Steam Crane.



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3 " " 5½ "	×	11 "	85	9 " " 9½ "	×	16 "	180
4 " " 6½ "	×	13 "	105	11 " " 10¾ "	×	18 "	210

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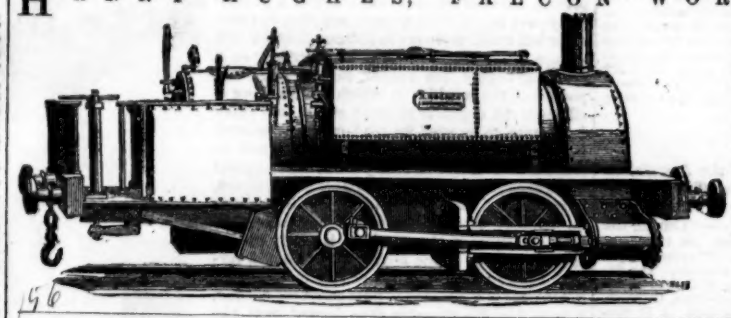

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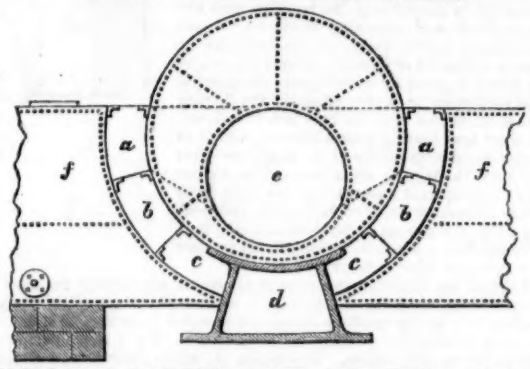
PATENT FLUE AND TANK BOILER.



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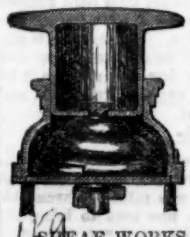

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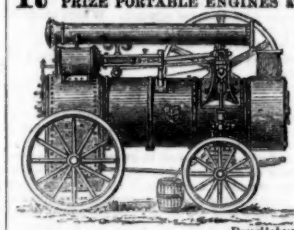

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